Kathleen Grey

Paleontology Report No. 2013/05

PALYNOLOGY OF DRILLHOLE JAMISON 1 (WARRAMBAN 1:100 000 SHEET; TANUMBIRINI 1:250 000 SHEET) BEETALOO BASIN, NORTHERN TERRITORY, AUSTRALIA

by

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Abstract

Samples from drillhole Jamison 1 (held in the NTGS core library in Darwin, Northern Territory) were collected by John Gorter on behalf of ENI and examined by Kathleen Grey as part of a reassessment of the hydrocarbon prospectivity of the Beetaloo Basin. Sixteen palynological samples, four from the Chambers River Formation and twelve from the Kyalla Formation, were prepared using a modified preparation technique. Unfortunately, poor preparation has prevented thorough examination of the some of the samples. Initial examination indicated abundant, diverse, extremely well-preserved palynomorphs from parts of the succession, including many new taxa that could not readily be assigned to existing species or precisely dated. Because of the difficulties presented by these previously undescribed taxa, slides were set aside until time was available for a more detailed examination. Further work has now been carried out, but it still has not been possible to do more than document some of the more common species. A more extensive study is needed to define the taxa present and document their stratigraphic distribution. The general aspect of the assemblage indicates a Mesoproterozoic age. More detailed analyses should provide a biostratigraphic scheme covering much of the Mesoproterozoic Beetaloo Basin succession. Such a scheme would have considerable potential for correlation of hydrocarbon exploration drillholes in the Beetaloo Basin.

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Drillhole Specifications

COREDAT ID: 1937
Drill Hole / Well Name: Jamison 1
Tenement: EP18
Operator: Pacific Oil and Gas
Core Type: Petroleum Core
Location: Darwin
Hylogged: Yes
100K Name: Warramban
250K Name: TANUMBIRINI
MGA94 Easting: 368612, MGA94 Northing: 8144943, UTM Zone: 53
Latitude: 16°46'29.49"S, Longitude: 133°46'1.90"E
Geological Region: McArthur Basin
Total depth: 1766.8 m

Locality details and sampling

Drillhole Jamison 1, a petroleum drillhole located on TANUMBIRINI 1:250 000 sheet, was drilled by Pacific Oil and Gas on the eastern flank of the main depocenter for the Beetaloo Basin (Table 1), (Silverman et al., 2007). It reached TD at a depth of 1766.8 m and was fully cored below 410.2 m. It bottomed in the in the Moroak Sandstone after penetrating the Antrim Plateau Volcanics (372–475.62 m), Bukalora Sandstone (475.62–501.46 m), Chambers River Formation (501.46–871.04 m), Bukalorkmi Sandstone (871.04–968.8 m), Kyalla Formation (968.8–1714.32 m), and the upper 52.5 m of Moroak Sandstone (1714.32–1766.85 m). Sixteen palynological samples (4 from the Chambers River Formation and 12 from the Kyalla Formation) were collected by John Gorter on behalf of ENI (Fig. 1, Table 2). Samples were prepared using a modified preparation technique designed to extract large fragile specimens from Proterozoic samples (Grey, 1999) by Core Laboratories Australia Pty. Ltd, P.O Box 785, Cloverdale, WA, 6105, Australia, Email : corelab.australia@corelab.com.

Some of the samples examined contain a diverse and well preserved biota, similar to that observed elsewhere in the Beetaloo Basin (Table 2). In particular, material from the Chambers River Formation is especially abundant and well preserved, and well preserved palynomorphs are present in at least the upper Kyalla Formation. However, it is almost impossible to recognize material because of poor quality preparations. Additional laboratory preparation is indicated. Many specimens are difficult to assign because of the scarcity of literature covering taxa of this age, and they may be new species. Preliminary results and illustrations of some of the better preserved specimens are given below.

Table 1. Drillhole location

Drillhole	Latitude	Longitude
Jamison 1	16°46'29.49"S	133°46'1.90"E

Report

Abundant, well preserved palynomorphs are present in the three lower of the four samples from the Chambers River Formation. Selected specimens are illustrated in Figures 2A-I, 3A-K and 4A-D.

A few specimens are present in the uppermost sample (561 m) but they are poorly preserved. Samples from 724.3 m, 774.7 m and 870.82 m contains a rich and diverse assemblage. In particular, the formation is characterized by filaments and filament sheaths (Figs 2A,B) and including chain-like aggregates of coccoids arranged in a cuboid pattern (Figs 2C,D); complex filamentous structures composed of linked spheres, here placed in *Chlorogloeaopsis contexta* (Fig. 2E), a species previously recorded in the Chambers River Formation in Balmain 1; and linked chains of large cells have been assigned to *Arctacellularia ellipsoidea* (Figs 2F-I), which are also present at this level in Balmain 1.

Chuaria cf. *circularis* (Fig. 3A) and various species of leiospheres (Figs 3B-D) are common, and *Simia annulare*, a form with a membrane (Fig. 3E) is present. However the assemblage is dominated by coenobial aggregates of various sizes, including abundant clusters of small, tightly packed spheres forming somewhat irregular clusters assigned to *Myxococcoides* sp. (Figs3F,G); spherical clusters of various sizes, tentatively assigned to *Symplassosphaeridium* spp. (Figs 3H,I) and more regular spherical clusters assigned to *Satka* sp., (Fig. 3J) in the case of a small form and *Satka colonialica* (Fig. 3K), in the case of larger specimens.

The Kyalla Formation samples show less diversity and are more poorly preserved, although the poor quality of the preparations has prevented logging of the samples in detail. Diversity appears greatest in the upper Kyalla Formation. Of note are several specimens of a

leiosphere-like species with an apparent equatorial ridge or thickening (Figs 4A-D) present at 1135.6 m. Otherwise, taxa are generally long ranging forms.

Problems with sample preparation have hindered identification and results could be considerably improved if more attention was paid to laboratory work. Standard palynological methods often do not produce good results for Proterozoic material. Preparation methods designed to reduce the stages of processing and eliminate vigorous methods, which tend to fragment large specimens, generally give better results (Grey, 1999). Although Grey's methods were supposedly applied here, not enough care was taken with preparation. A high proportion of fluorides is present, indicating insufficient treatment with boiling hydrochloric acid. Samples were inadequately filtered, so even coarse fractions contain large amounts of fine debris, resulting in flocculation. Specimen density is too high in most slides, hampering identification and specimens are obscured by fine debris. Some slides were overheated, browning the mounting medium, affecting specimen colour, and cracking both the medium and contained specimens. Contamination is common, and includes modern pollen grains and a fungus that grows in out-of-date polyvinyl alcohol, a dispersing agent used to spread the macerate evenly on slides.

Microfossils recovered from Jamison 1 and other drillholes in the Beetaloo Basin show considerable promise for biostratigraphic correlation, but require further documentation of distributions patterns, as well as systematic description. The assemblage contains several species seen in other Beetaloo Basin drill cores, including the abundant small coenobial aggregates common in the Chambers River Formation. It is consistent with microfossils first described from the Roper Group by Peat et al. (1978) from the McMinn Formation but so far, no specimens of the large, process-bearing *Tappania plana* or associated forms, previously recorded by Javaux et al. (2001) from the underlying Corcoran, Jalboi and Mainoru Formations, have been observed. It has a few elements of the 1270±4 to c. 850 Ma Bylot Supergroup of Arctic Canada (Hofmann and Jackson, 1994, Knoll et al., 2013) and a few taxa similar to ones reported from younger Mesoproterozoic stratigraphic units such as the c. 1000 Ma Lakhanda Formation and late Mesoproterozoic Miroyedikha Formations of Siberia (Jankauskas et al., 1989; Bartley et al., 2001).

The thermal alteration index of organic material (TAI), based on well-established Phanerozoic measurements of organic maturity (Batten, 1996; Traverse, 2007), indicates that organic matter in the Chambers River Formation has reached a level of 3 to 3+ and is slightly undermature to mature for petroleum formation. The underlying Kyalla Formation is slightly more mature, although overheating of the kerogen slides makes this difficult to determine with certainty. It appears to be within the range for oil and gas generation. These results may be slightly inconsistent with Rock-Eval pyrolysis and vitrinite reflectance studies (Warren et al., 1998). TAI is determined from pre-oxidation macerate slides. Determinations are currently based on spore colouration, which is a rough guide only, partly because acritarchs biopolymers have a slightly different chemical composition to sporopollenin, and partly because Precambrian organic material has not so far been adequately calibrated with Phanerozoic material, or with burial history. Kerogen colour in Precambrian rocks has more to do with depth of burial, tectonic stress, or heating by thermal fluids than it does to age or redox values (Schiffbauer et al., 2012), and follows similar pathways to those observed in Phanerozoic successions (Batten, 1996; Traverse, 2007).

This preliminary study shows that a rich, well preserved and diverse palynoflora is present in the Chambers River Formation, whereas a less well preserved assemblage is present in in the upper part of the Kyalla Formation, but becomes more poorly preserved in lower samples. The assemblages show good potential for correlation with other drillholes in the Beetaloo Basin. More detailed analysis, including systematic studies and the description of potentially new species, is required. Palynology could also assist in determining both sedimentary facies and organic facies and shed further light on the thermal maturity of Mesoproterozoic strata within the basin.

Summary of samples

Figure 1. Samples and lithology

Drillhole: Jamison 1

ENI sample no.	Depth (m)	No of slides	Type	Formation	Lithology hand specimen
12969	561.1	5	core	Chambers River Formation	fine-grained argillite-claystone
12971	724.3	5	core		fine-grained argillite
12973	774.7	5	core		fine-grained argillite-claystone
12975	870.82	5	core		
12978	1130.7	5	core	Kyalla Formation	interbedded fine-grained argillite and claystone
12979	1130.9	5	core		fine-grained argillite containing unidentified porphyroblasts
12980	1135.6	5	core		fine-grained argillite containing unidentified porphyroblasts
12983	1237	5	core		bedded fine-grained argillite and claystone
12984	1239.5	5	core		fine-grained argillite containing unidentified porphyroblasts
12981	1297.3	5	core		fine-grained, limonite-stained argillite
12985	1300	5	core		fine-grained argillite
12986	1397	5	core		fine-grained, limonite-stained argillite containing possible oolite casts (?)
12987	1400.9	5	core		fine-grained, limonite-stained argillite
12988	1401.3	5	core		fine-grained, limonite-stained argillite containing possible oolite casts (?)
12989	1598.6	5	core		fine-grained, limonite-stained argillite
12990	1601.9	5	core		fine-grained, limonite-stained argillite

Table 2. Summary of palynology

Depth (m)	Palynomorphs	Preservation	TAI*	Probable stratigraphic age
561.1	*Leiosphaeridia crassa* *Leiosphaeridia minutissima* *Synsphaeridium* sp.	excellent	3+	Mesoproterozoic
724.3	*Chlorogloeaopsis contexta* *Chuaria* cf. *circularis* *Leiosphaeridia crassa* *Leiosphaeridia tenuissima* *Myxococcoides* sp. *Satka* ?*colonialica* *Simia annulare* *Symplassosphaeridium* sp. *Synsphaeridium* sp. Chains of spheres in cuboids	excellent	3	Mesoproterozoic
774.7	*Arctacellularia ellipsoidea* *Chlorogloeaopsis contexta* *Chuaria* cf. *circularis* *Leiosphaeridia crassa* *Leiosphaeridia tenuissima* *Myxococcoides* sp. *Satka* ?*colonialica* *Siphonophycus* spp. *Symplassosphaeridium* spp.	excellent	3+	Mesoproterozoic
870.82	*Leiosphaeridia crassa* *Leiosphaeridia jacutica* *Myxococcoides* sp. *Satka* ?*colonialica* *Siphonophycus* spp. *Symplassosphaeridium* spp. *Synsphaeridium* sp.	excellent	3+	Mesoproterozoic
1130.7	Poorly preserved palynomorphs	moderate	?	Mesoproterozoic
1130.9	Poorly preserved palynomorphs	moderate	?	Mesoproterozoic
1135.6	Leiosphere with equatorial ridge Poorly preserved palynomorphs	moderate	?	Mesoproterozoic
1237	Poorly preserved palynomorphs	moderate	?	Mesoproterozoic
1239.5	Not logged in detail	poor	?	?
1297.3	Not logged in detail	poor	?	?
1300	Not logged in detail	poor	?	?
1397	Not logged in detail	poor	?	?

1400.9	Not logged in detail	poor	?	?
1401.3	Not logged in detail	poor	?	?
1598.6	Not logged in detail	poor	?	?
1601.9	Not logged in detail	poor	?	?

Conclusions

Palynomorphs, comprising acritarchs, cyanobacteria, filaments and problematic forms are present, and well preserved in the Chambers River Formation, more moderately preserved in the upper Kyalla Formation and poorly preserved in the lower Kyalla Formation in Jamison 1. It is difficult to comment on samples from the lower part of the drillhole because of the combination of a degraded assemblage and poor quality preparation. Preliminary indications are that palynomorphs from the Chambers Hill Formation and upper Kyalla Formation have good correlation potential for the upper Roper Group. It is difficult to determine the stratigraphic age at present, other than to suggest that the assemblage has a Mesoproterozoic aspect. Many of the taxa require description and categorization before a zonal scheme can be proposed.

Recommendations for further work

Most samples require re-preparation before adequate analysis can be undertaken. Despite preparation problems, the upper part of the drillhole shows excellent preservation and contains palynomorphs suitable for biostratigraphic correlation. The lower Kyalla Formation requires more study to determine its potential. It is known to yield palynomorphs elsewhere in the basin. It is strongly recommended that further palynological analysis be undertaken on Jamison 1 and other selected Beetaloo Basin drillholes. Additional sampling from this drillhole is indicated.

There is potential for the development of a correlation scheme that would have application both for the hydrocarbon-prone Beetaloo Basin, as well as globally. Additional studies are needed to calibrate TAI determined from the organic matter colour in Proterozoic

sediments with maturity determined from vitrinite reflectance and Rock-Eval pyrolysis but requires standardization before it can be used with confidence. TAI has the potential to be a valuable indicator of thermal gradient. Further palynological studies would be a suitable project for a PhD or post-doctoral student.

References

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Traverse A, 2007, Palaeopalynology (Second edition), Topics in Geobiology, v. 28, Springer, Dordrecht, The Netherlands, 814 p.

Warren JK, George SC, Hamilton, PJ and Tingate P, 1998, Proterozoic source rocks: Sedimentology and organic characteristics of the Velkerri Formation, Northern Territory, Australia: American Association of Petroleum Geologists, Bulletin, 82, p. 442–463.

Appendix 1: Log details for individual samples

561.1 Chambers River Formation

The sample contains only a few palynomorphs and nothing is immediately diagnostic. Preservation is generally poor. Abundant fine organic particles are present, together with poorly preserved spheres and a small quantity of large organic fragments, mostly derived from bacterial mat. Fluoride crystals were formed during preparation but are not too much of a problem because they are large and crystalline and do not obscure the other material. Spherical structures in the -10 fraction seem too large for the filter size and are probably aggregates of fine debris. There are also traces of PVC contamination. Organic material in the kerogen slide indicates a TAI of 3+.

Species identified include: *Leiosphaeridia crassa*, *Leiosphaeridia minutissima* and *Synsphaeridium* sp.

Zone	Indeterminate
Probable age	Mesoproterozoic

724.3 Chambers River Formation

The sample contains abundant, well preserved palynomorphs, many consistent with a Mesoproterozoic age. It also contains abundant organic material and numerous acritarchs, especially leiospheres and numerous coenobial clusters, tentatively assigned to

Myxococcoides, *Symplassosphaeridium* and *Satka*, based mainly on size and degree of structure. Degraded filaments and filament sheaths are common. Large amorphous fragments are abundant. The sample has only been partially logged because of the problem of working on the poorly prepared slides. Fluorides and inadequate filtration are a problem and it would be better to work on filtered material. Many specimens show surface corrosion by pyrite framboids. Organic material in the kerogen slide indicates a TAI of 3.

Species identified include: *Chlorogloeaopsis contexta*, *Chuaria* cf. *circularis*, coccoids in cuboid arrangement, *Leiosphaeridia crassa*, *Leiosphaeridia tenuissima*, *Myxococcoides* sp., *Satka* ?*colonialica*, *Simia annulare*, *Symplassosphaeridium* sp. and *Synsphaeridium* sp.

Zone	Indeterminate
Probable age	Mesoproterozoic

774.7 Chambers River Formation

The sample contains abundant well preserved palynomorphs, many consistent with a Mesoproterozoic age. It also contains abundant organic material and numerous acritarchs, especially leiospheres and numerous coenobial clusters, tentatively assigned to *Myxococcoides*, *Symplassosphaeridium* and *Satka*, based mainly on size and degree of structure. Degraded filaments and filament sheaths are common. Large amorphous fragments are abundant. The sample has only been partially logged because of the problem of working on the poorly prepared slides. Fluorides and inadequate filtration are a problem and it would be better to work on filtered material. Many specimens show surface corrosion by pyrite framboids. Organic material in the kerogen slide indicates a TAI of 3+.

Species identified include: *Arctacellularia ellipsoidea, Chlorogloeaopsis contexta*, *Chuaria* cf. *circularis*, *Leiosphaeridia crassa*, *Leiosphaeridia tenuissima*, *Myxococcoides* sp., *Satka* ?*colonialica*, *Siphonophycus* spp., *Symplassosphaeridium* spp.

Zone	Indeterminate
Probable age	Mesoproterozoic

870.82 Chambers River Formation

The sample is very rich and contains abundant, well-preserved palynomorphs. Most are long ranging, but the general aspect suggests this is Mesoproterozoic. The sample has only been partially logged because of the problem of working on the poorly prepared slides. The kerogen slide has been overheated and the mounting medium has cracked. Fluorides and inadequate filtration are a problem and it would be better to work on filtered material. The sample contains abundant, fine organic particles and numerous mineral grains, probably of pyrite. Many specimens show surface corrosion by pyrite framboids. Numerous spheres, most probably leiospheres, are common. Coenobial aggregates of various sizes are abundant, as are filaments. Organic material in the kerogen slide indicates a TAI of 3+.

Species identified include: *Leiosphaeridia crassa*, *Leiosphaeridia jacutica*, *Myxococcoides* sp., *Satka* ?*colonialica*, *Siphonophycus* spp., *Symplassosphaeridium* spp. and *Synsphaeridium* sp.

Zone	Indeterminate
Probable age	Mesoproterozoic

1130.7 Kyalla Formation

The sample contains well preserved palynomorphs, including spheres and filaments, but it is difficult to identify anything because the slide is too densely mounted. The sample has not been logged because of the problem of working on the poorly prepared slides. Fluorides and inadequate filtration are a problem and it would be better to work on filtered material.

Zone	Indeterminate
Probable age	Mesoproterozoic

1130.9 Kyalla Formation

The sample contains well preserved palynomorphs, including spheres and filaments, but it is difficult to identify anything because the slide is too densely mounted. The sample has not been logged because of the problem of working on the poorly prepared slides. Fluorides and inadequate filtration are a problem and it would be better to work on filtered material.

Zone	Indeterminate
Probable age	Mesoproterozoic

1135.6 Kyalla Formation

The sample contains well preserved palynomorphs, including spheres and filaments, but it is generally difficult to identify anything because the slide is too densely mounted. Several specimens of a leiosphere-like species with an apparent equatorial ridge or thickening is present. The sample has not been logged because of the problem of working on the poorly prepared slides. Fluorides and inadequate filtration are a problem and it would be better to work on filtered material.

Zone	Indeterminate
Probable age	Mesoproterozoic

1237 Kyalla Formation

The sample contains well preserved palynomorphs, including spheres and filaments, but it is difficult to identify anything because the slide is too densely mounted. The sample has not been logged because of the problem of working on the poorly prepared slides. Fluorides and inadequate filtration are a problem and it would be better to work on filtered material.

Zone	Indeterminate
Probable age	Mesoproterozoic

1239.5 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

1297.3 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

1300 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

1397 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

1400.9 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

1401.3 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

1598.6 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

1601.9 Kyalla Formation

Preservation is poor and identifiable palynomorphs sparse. The sample has not been logged because of the problem of working on the poorly prepared slides. Re-preparation of the material might improve yields and produce some results.

Zone	Indeterminate
Probable age	Mesoproterozoic

Appendix 2: Taxonomic citations

The names of authors of scientific names were omitted in the text and instead are listed here. They are the names of taxonomic authors, not references, so are not necessarily cited in the references.

Arctacellularia ellipsoidea German *in* Timofeev et al., 1976
Chlorogloeaopsis contexta (German 1976) Hofmann and Jackson 1994
Chuaria cf. *circularis* Walcott 1899; emend. Vidal & Ford 1985
Leiosphaeridia crassa (Naumova, 1949) Jankauskas 1989 in Jankauskas et al., 1989
Leiosphaeridia jacutica (Timofeev 1966) Mikhailova and Jankauskas 1989 in Jankauskas et al., 1989
Leiosphaeridia minutissima (Naumova, 1949) emend. Jankauskas 1989 in Jankauskas et al., 1989
Leiosphaeridia tenuissima Eisenack 1958
Myxococcoides sp. Schopf 1968
Satka colonialica Jankauskas 1979
Simia annulare (Timofeev, 1969) Mikhailova & Jankauskas in Jankauskas *et al*. 1989
Siphonophycus Schopf 1968 emend. Knoll, Swett and Mark 1991
Symplassosphaeridium Timofeev 1959 ex Timofeev 1969
Synsphaeridium Eisenack 1965
Tappania plana Yin L 1997

Figure 2

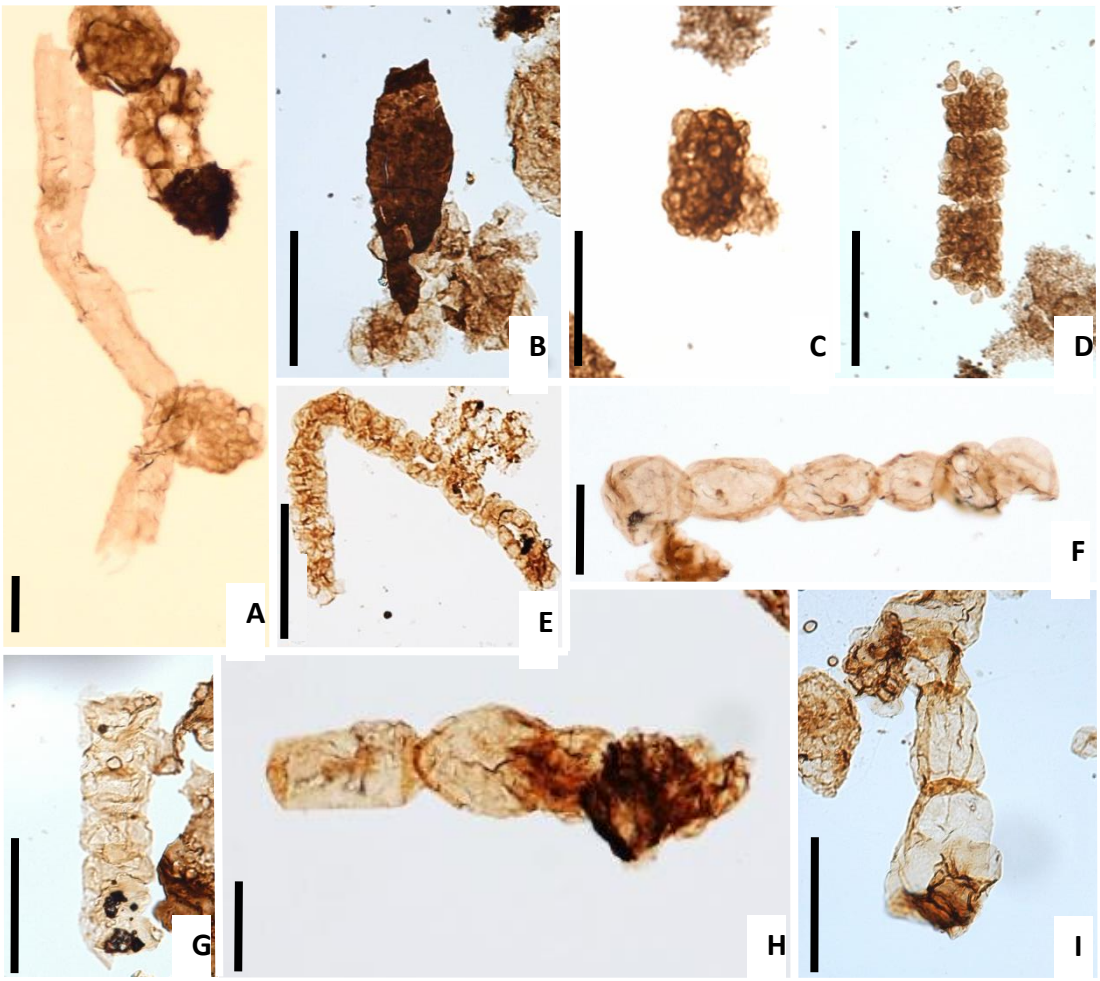

Figure 2. Selected palynomorphs from the Chambers River Formation in Jamison 1. A, broad sheath. 774.7 m/2, 69M2; B, ovoid sheath, 724.3 m/3, 59K0; C, D, chain of coccoids in cuboids, C, 724.3/m, 66Q2; D, 724.3 m/3, 54M1; E, *Chlorogloeaopsis contexta*, 724.3 m/3, 62P4; F-H, *Arctacellularia ellipsoidea*; F, 774.7 m/2, 69U2; G, 774.7 m/2, 42D2; G, 774.7 m/2, 72J3; H, 774.7 m/2, 72J3; I, 774.7 m/2, 69U2. England Finder co-ordinates are given for each specimen. Scale bar is 20 µm.

Figure 3

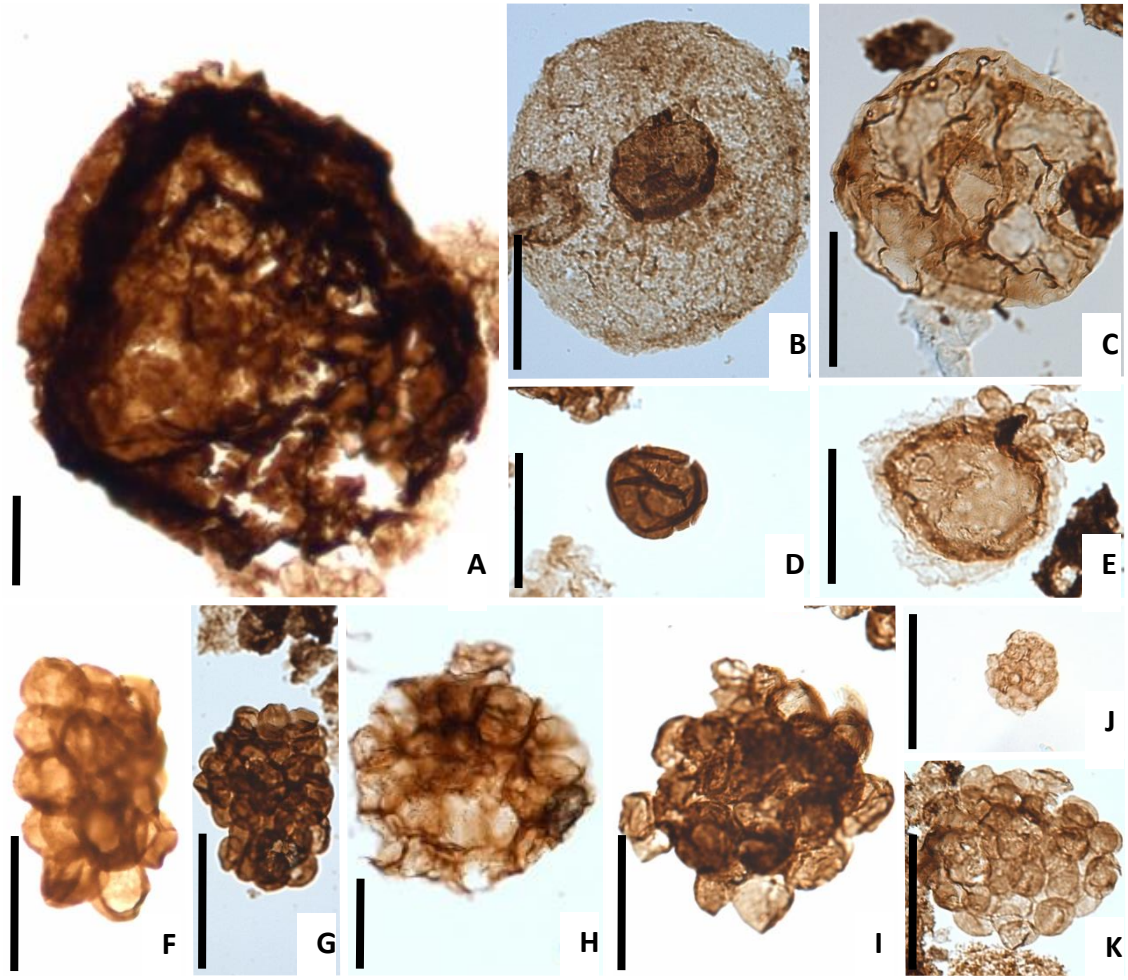

Figure 3. Selected palynomorphs from the Chambers River Formation in Jamison 1. A, *Chuaria* cf. *circularis*, 774.7 m/2, 69G0; B, *Leiosphaeridia crassa* superimposed on large degraded leiosphere, 724.3 m/3, 44N0; C, *Leiosphaeridia tenuissima*, 724.3 m/3, 50M0; D, *Leiosphaeridia crassa*, 724.3 m/3, 53V4; E, *Simia annulare*, 724.3 m/3, 53V4; F, *Myxococcoides* sp., 774.7 m/2, 71H2; G, *Myxococcoides* sp., 724.3 m/3, 66Q2; H,I, *Symplassosphaeridium* sp., H, 774.7 m/2, 64T3; I, 724.3 m/3, 54R0; J,K, *Satka* sp., J, small, 774.7 m/2, 68H2; K, *Satka colonialica*, large, 724.3 m/3, 52L2. England Finder co-ordinates are given for each specimen. Scale bar is 20 µm.

Figure 4

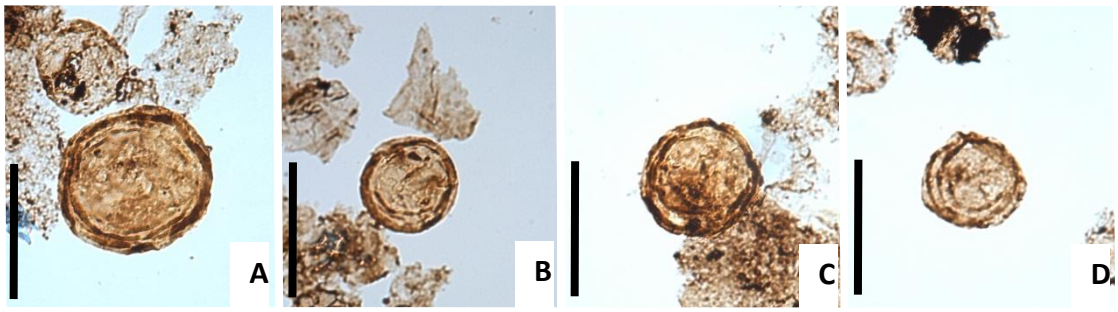

Figure 4. Selected palynomorphs from the Kyalla Formation in Jamison 1, 1135.6 m/2. A-D, leiosphere with equatorial ridges, A, 63E0; B, 67F2, C, 70J4; D, 71J2. England Finder co-ordinates are given for each specimen. Scale bar is 20 µm.